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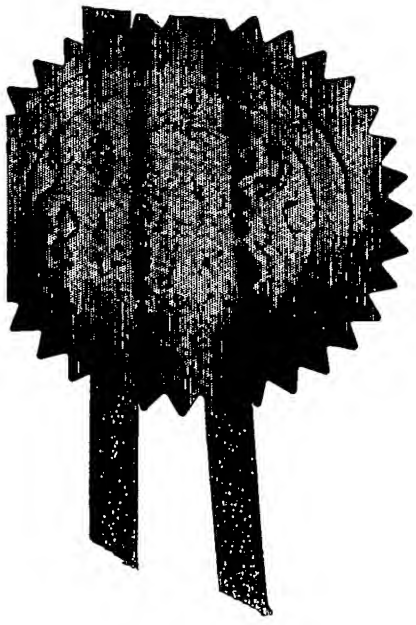

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Dated 22 July 2004

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P01/7700 0.00-0406758.3 ACCOUNT CHA

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1. Your reference

P4359.A1/PAG

2. Patent application number
(The Patent Office will fill in this part)

0406758.3

3. Full name, address and postcode of the or of each applicant *(underline all surnames)*

Martin John Lenzini
Nevada, Thetford Road, Coney Weston,
BURY ST EDMUNDS, Suffolk, IP31 1DN
United Kingdom

Patents ADP number *(if you know it)*

If the applicant is a corporate body, give the country/state of its incorporation

05888045002

4. Title of the invention

Vacuum Hold-down

5. Name of your agent *(if you have one)*

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"Address for service" in the United Kingdom to which all correspondence should be sent *(including the postcode)*

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Country	Priority application number *(if you know it)*	Date of filing *(day / month / year)*

7. Divisionals, etc: Complete this section only if this application is a divisional application or resulted from an entitlement dispute *(see note f)*

Number of earlier application	Date of filing *(day / month / year)*

8. Is a Patents Form 7/77 (Statement of inventorship and of rights to grant of a patent) required in support of this request?

No.

Answer 'Yes' if:

a) any applicant named in part 3 is not an inventor, or
b) there is an inventor who is not named as an applicant, or
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9. Accompanying documents: A patent application must include a description of the invention. Not counting duplicates, please enter the number of pages of each item accompanying this form:

Continuation sheets of this form	
Description	14
Claim(s)	4
Abstract	1
Drawing(s)	13

10. If you are also filing any of the following, state how many against each item.

Priority documents	
Translation of priority documents	
Statement of inventorship and right to grant of a patent *(Patents Form 7/77)*	
Request for preliminary examination and search *(Patents Form 9/77)*	
Request for substantive examination *(Patents Form 10/77)*	
Any other documents *(please specify)*	

11. I/We request the grant of a patent on the basis of this application.

Signature(s) Dummett Copp Date 26 March 2004

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12. Name, daytime telephone number and email address, if any, of person to contact in the United Kingdom

Peter Gemmell
01473 660600
mail@dummett.com

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VACUUM HOLD-DOWN

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a vacuum hold-down device for holding a workpiece or component for machining.

2. Description of the Prior Art

Vacuum devices for holding work objects have been known for some time. DE 4221222 describes a vacuum hold-down device comprising a base plate with suction openings connected to a vacuum system. A top plate on which work objects are laid has vertical holes from the underside right through to the upper surface and there is a seal surrounding these holes under the underside and another similar seal on the top surface. The holes in the base plate not overlain by the top plate are closed with stoppers. The device is complex to construct, and few small workshops have suitable vacuum lines for connection to the suction openings.

Also known are systems which employ pistons to create a partial vacuum to hold a workpiece, as described in US 5,626,378, US 4,470,585, GB 1,588,012, GB 2 120 141, DE 42 15 140, and SU 1079373. The pistons act on a deformable material, for example a flexible membrane or a suction cup, which in turn subjects the workpiece to a partial vacuum. In another application, FR 2 262 751 describes the use of a piston to clamp a workpiece to marble. The use of pistons, and means to return the pistons to a rest

position adds to cost and manufacturing complexity. Moreover, flexible suction cups or membranes do not work well with steel workpieces; swarf associated with the machining process rapidly causes damage to the flexible material of the membrane or suction cup.

The present invention seeks to reduce at least some of the problems of the prior art devices.

SUMMARY OF THE INVENTION

According to an aspect of the present invention there is provided a vacuum hold-down device comprising a base member and a workpiece support which co-operate to define a vacuum chamber, and a venturi having an inlet port for connection to a source of pressurized fluid, an outlet for fluid from the venturi, and a fluid connection from a low pressure region of the venturi to the inside of the vacuum chamber, for providing a partial vacuum therein, which partial vacuum will hold the base member and the workpiece support together to maintain a peripheral seal therebetween; wherein the workpiece support is provided with securing means for securing a workpiece thereon.

By providing a venturi connection to the chamber the device may be operated by connecting the inlet port to a suitable pressurized fluid source, for example compressed air, which is typically available in a machining environment. Compressed air is preferred because it is readily available and clean, however other pressurized fluids could also be used, for example pressurized water, or coolant from the machine.

In a preferred embodiment, the base member and the workpiece support are plates or are of plate-like construction. The invention will for convenience be described herein with reference to the use of a base plate and a work plate, but it will be understood that the invention is not limited by the shape of the base member or the workpiece support.

In one embodiment the securing means comprises clamping means on an external surface of the work plate (the work surface) for releasably clamping one or more workpieces which are to be machined. There may be a plurality of work plates, each of which may be made ready by having one or more workpieces clamped to it. After the first work plate has been secured to the base member, preferably by means of the applied vacuum alone, and the workpiece or pieces have been machined, the first work plate may be quickly removed after momentary release of the vacuum, to be replaced by a new work plate with new workpieces for machining.

In another embodiment, the securing means comprises a plurality of holes in the work plate, which provide fluid communication between the inside of the vacuum chamber and the work surface of the work plate. The holes provide vacuum hold-down of the workpiece. They may comprise the sole means for securing the workpiece or pieces, or additional clamping means, for example mechanical clamps, may be provided.

It is preferred that the plates are readily separable when not under vacuum to enable the work plate to be removed and quickly replaced by another work plate, thereby minimizing machine downtime. By securing the work plate to the base

plate by means of the vacuum, the work plate may be quickly removed and replaced by momentarily reducing the vacuum. This may readily be achieved either by turning off the pressurized fluid flow or by opening a vent to connect the vacuum chamber to the atmosphere, for example a stop-cock located at the low pressure region of the venturi.

On larger base plates the partial vacuum in the vacuum chamber may be applied through holes in the base plate to aid clamping of the device to a machine table on which the machining operation is to take place. This may help to reduce vibration and is of particular use for machining a component secured near the centre of a plate or in areas inaccessible to conventional clamping.

Where a magnetic machine chuck is to be used, the base plate may be made from a ferrous metal, for example steel, so that it is held firmly by the magnetic chuck.

The venturi could be provided separately from the base plate. However for convenience and simplicity, it is preferred that the venturi is provided at least partly within a housing associated with the base plate. Preferably, the venturi is housed substantially within the footprint of the base plate.

The vacuum chamber is defined between inner surfaces of the base plate and the work plate, and is preferably of quite small depth relative to its breadth and width to keep the vacuum volume small. Preferably the depth is the range 0.05 to 0.5 mm, notably 0.1 to 0.2 mm. It is preferred that the depth is provided substantially or entirely by a recessed region in the upper surface of the base plate, but some or

all of the depth could also be provided by a recess in the work plate.

In a preferred embodiment, the invention provides a vacuum workholding system having a common base plate and a plurality of work plates. Each work plate may be of identical design, or some or all of the work plates may be different for machining different components.

Other aspects and benefits of the invention will appear in the following specification, drawings and claims.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention will now be further described, by way of example, with reference to the following drawings in which:

Figure 1 is a view from one corner showing a vacuum hold-down device according to an embodiment of the present invention, with the base plate and work plate separated;

Figure 2 is a perspective view from an opposite corner of the device of Figure 1 with the base plate and work plate assembled together;

Figure 3 is a sectional view through part of the device shown in Figure 2, along the lines I-I;

Figure 4 is a perspective view of a vacuum hold-down device according to another embodiment of the present invention;

Figure 5 is a perspective view of a vacuum hold-down device according to a further embodiment of the present invention, with a workpiece on the work plate;

Figure 6 is a perspective view of a different embodiment of the invention, with hidden parts shown in faint lines; and

Figures 7 and 8 are views of vacuum hold-down devices according to further different embodiments of the invention.

DETAILED DESCRIPTION

The vacuum hold-down device shown in Figures 1-3 comprises a base plate 1 and a work plate 8 which co-operate to define a vacuum chamber. The base plate 1 is typically formed from a metal, for example steel or aluminium; however other metals may be employed, or structural plastics materials.

The base plate 1 has integral slots 2 formed therein, for clamping it to an existing machine bed or table. Locating dowels 17 permit precise, square location of the base plate on the machine table prior to clamping. The upper surface of base plate 1 has a slightly recessed region 4, surrounded by an "O" ring seal 3 for co-operating with the inner (lower) surface of the work plate 8 to define the vacuum chamber. It will be understood that the recessed region could alternatively be provided on the lower surface of the work plate 8, or on both plates. A pair of location dowels 6 are provided on the base plate 1, which fit in corresponding location holes 13 in the workpiece support to ensure correct seating of the workpiece support 8 on the base plate 1. The arrangement of location dowels and location holes could of course be reversed.

The work plate 8 is made of metal and has on its upper (work) surface a number of locations 12 for receiving component workpieces 10 for machining. A component clamp 16 is provided for securing each workpiece 10 to the work surface. A pair of pallet change handles 11 are provided on the work plate 8 to facilitate moving of the work plate.

Referring now to Figure 3, the base plate incorporates a

venturi vacuum generator 15. The venturi 15 has a fluid inlet port 7, in this example for receiving a stream of compressed air. The air flows through a narrowing chamber 18 in the venturi, and may reach a speed in excess of 950 km/h before exiting through an exhaust fluid outlet 9 and passing through a channel in the machine table. A port 19 at the lowest pressure region in the venturi communicates with the inside of the vacuum chamber *via* a transfer port 5 in the base plate 1. Thus, when pressurized air passes through the venturi 15, it draws air from the vacuum chamber and creates a partial vacuum which holds the work plate 8 firmly in place on the base plate 1.

Within the recessed region 4 of the base plate 1 are located a series of upstands 14, which are machined to the same plane as the area surrounding the recessed region 4. These provide support to the work plate 8, and give a large parallel clamping face with a high clamping potential. I have calculated that a 500 mm square fixture with a vacuum chamber area of area about 0.2 m^2 and depth about 0.2 mm may be acted upon by an effective total force of over 1800 kg depending on the degree of vacuum available from the venturi.

It would be quite possible to mount the venturi externally; but by mounting it within the area of the base plate the volume of vacuum which has to be generated is reduced.

For larger batches, a pair of work plates 8 may be provided. Various components 10 may be loaded onto the free work plate 8 while components 10 on the other work plate 8 are being machined. On completion of the machining process, the work plates may be quickly swapped, thereby minimizing machine

down-time.

Referring now to Figure 4, the base plate 1 is shown loaded with a universal work plate 8. The plate 8 is provided with an array of holes which connect the upper work surface to the inside of the vacuum chamber. Each hole is surrounded by a sealing "O" ring 22 and may be plugged with a vacuum retention screw 21. This work plate can be used for virtually any shaped component to be held by vacuum. The component can be laid onto the universal work plate 8 so that it can be worked out which vacuum retention screws 21 should be removed to allow vacuum clamping in those areas where the component is to be located. The process may comprise laying the component on the work surface; drawing a line around its periphery; removing the component; and removing the vacuum retaining screws 21 within the drawn periphery. The component may then be replaced and the venturi operated.

The work plate 8 shown in the embodiment of Figure 5 is specially adapted for a particular shape of component 10. The base plate 1 is unchanged. A plurality of vacuum hold-down holes may be provided in the work plate, surrounded by sealing "O" rings, only in the area where the component 10 is to be located. Alternatively, a single large opening may be provided, surrounded by a sealing ring. The large opening may be shaped to match the periphery of the component and maximize the clamping force. This arrangement is well suited for regularly machined components, to reduce set-up time.

On larger plates, the vacuum could also be transferred through the base of the base plate 1, as illustrated in Figure 6. In this embodiment, three venturi intakes 7 are

provided, each of which is associated with an "O" ring seal 25 in the base of the base plate 1. A single seal 3 is provided in the top of the base plate 1, as previously described. Transferring the vacuum through the lower surface of the base plate aids its clamping to a table. This helps to reduce vibration, and is of particular use when machining the centre of a plate or an area inaccessible to conventional clamping. Although three venturis are used in this embodiment for illustrative purposes, it will be understood that only a single venturi, and a single lower "O" ring, or any desired number of either, could be used.

It would be possible to add "O" ring seals to a standard table as a retrofit, or to incorporate these in the manufacture of a new table. The rings would enable the use of vacuum hold-down as well as conventional clamping on the one base machine table 26, as illustrated in Figure 7.

Referring now to Figure 8, a magnetic chuck 28 is conventionally used for clamping ferromagnetic components. By forming the base plate 1 from a ferromagnetic material such as steel or, as in this embodiment, by providing the base plate 1 with an additional ferromagnetic plate 27 on its base, the base plate 1 may be magnetically clamped to the magnetic chuck 28. This permits the machining of non-ferromagnetic components on the magnetic chuck. In the illustrated embodiment, the base plate 1 and universal work plate 8 act as a vacuum chuck 20. Blanking screws 21 are removed in those areas where the component 10 to be machined is to be located. The steel plate 27 enables quick loading to the magnetic chuck 28. This is particularly useful in grinding machines, but this chuck could be located anywhere,

and would even be useful in assembly operations.

It is appreciated that certain features of the invention, which are for clarity described in the context of separate embodiments, may also be provided in combination in a single embodiment. Conversely, various features of the invention which are, for the sake of brevity, described in the context of a single embodiment, may also be provided separately or in any suitable subcombination.

While the present invention has been described with reference to specific embodiments, it should be understood that modifications and variations of the invention may be constructed without departing from the scope of the invention defined in the following claims.

SUCTION TABLE AS COMPLETE MACHINE BED ON NEW MACHINE (OR RETOFIT)

A new machine could just have a flat table with o ring encapsulating the outer perimeter And possibly two location dowels. To this you could add plates containing all the parts required for machining different components such as jigs/fixtures ,multi-vice set ups, with known datum positions in minutes. This would be useful not only for obvious cost savings but longer running jobs or those requiring less observation at night and other times of less labour intense periods

new

Fig 1 shows the standard components on rear of all (post 1990) cnc machines ie a pressure regulator and low pressure switch. A small extension piece is added between these two components with a small restriction hole large enough to run venturi valve efficiently.The air chamber before the venturi has a hole drilled of larger diameter than the restriction through to top of fixture ,see mods to fig 3 , an o ring seal (20) between the fixture and component. When a comp is held in place by vacuum it is ready for machining to take place. If there is a loss vacuum the air will be able to flow through hole 21, in direction of 22 this will cause a large pressure drop next to pressure sensor. This will in turn cause machine to show low pressure air alarm and put the machine emergency stop situation and stop the machine and spindle from finishing its operation. By using this method of using standard parts of machine tool to stop machine costs are reduced and no electrical wiring of machine to extra pressure sensors is required
The pressure outlet could also be mounted externally to the vacuum fixture in a separate housing mounting in this way would the vacuum could be linked externally and the release of pressure would be independent of the fixture weight.
A vacuum indictor (new fig 3) could also be incorporated into the pressure release.This could be held in manually until vacuum builds up to hold in place and in this position the air flow from pressure in is captivated by indicator pin in event of pressure drop the return spring pushes indicator pin out air is released through to exhaust this would cause a pressure drop and trip machine to emergency stop position as in new fig 3a

new

Fig 2 shows a standard fixture set up but with a larger venturi added .In this set up both valves would be turned on together to generate the vacuum .The larger of the two would exhaust through a non return valve and be used to quickly evacuate the large volume of air especially found in larger fixtures. When this is turned off ,the non-return valve holds the vacuum leaving the smaller working to retain the work piece .In this case 2 venturi were used but there is no limit to the number linked in this way. A number of venturi could also be linked to separate chambers to create a multitude of vacuum pockets

If the larger venturi had a higher evacuation rate and thus lower pressure if could be possible to use the pressure differential to activate a non return valve automatically Between the vacuum and this and the larger lower pressure venturi as the pressure rises as the smaller high pressure venturi raises the vacuum pressure .The air flow to this could be turned off manually or automatically

CLAIMS

1. A vacuum hold-down device comprising a base member and a workpiece support which co-operate to define a vacuum chamber, and a venturi having an inlet port for connection to a source of pressurized fluid, an outlet for fluid from the venturi, and a fluid connection from a low pressure region of the venturi to the inside of the vacuum chamber, for providing a partial vacuum therein, which partial vacuum will hold the base member and the workpiece support together to maintain a peripheral seal therebetween; wherein the workpiece support is provided with securing means for securing a workpiece thereon.

2. A device according to claim 1, wherein the said fluid connection to the inside of the vacuum chamber is *via* a port in the base member.

3. A device according to claim 1 or claim 2, wherein the vacuum chamber is provided with at least one internal support that spans the distance between major internal surfaces of the base member and the workpiece support.

4. A device according to claim 3, wherein the said at least one internal support comprises a plurality of elongate parallel upstands provided on the base member.

5. A device according to any preceding claim, wherein the major internal surfaces of the vacuum chamber are spaced apart by from 0.05 to 0.5 mm.

6. A device according to claim 5, wherein the major

internal surfaces of the vacuum chamber are spaced apart by from 0.1 to 0.2 mm.

7. A device according to any preceding claim, wherein the said securing means comprises a mechanical clamp for securing a workpiece.

8. A device according to any preceding claim, wherein the said securing means comprises at least one hole in the workpiece support, providing fluid communication between the inside of the vacuum chamber and the work surface on top of the workpiece support to which a workpiece is to be secured.

9. A device according to any preceding claim, wherein at least one hole is provided in the base member, providing fluid communication between the inside of the vacuum chamber and an outside surface of the base member, to enable vacuum hold-down of the base member on a supporting surface.

10. A device according to any preceding claim, wherein the base member is formed from or provided with a ferromagnetic material to enable it to be secured to a magnetic chuck by magnetism.

11. A device according to any preceding claim, wherein the venturi is disposed substantially within the footprint of the base member.

12. A device according to claim 1, wherein the base member is part of a machine table.

13. A vacuum hold-down device substantially as herein

described with reference to or as shown in the drawings.

14. Use of a venturi for providing vacuum hold-down in a vacuum device for holding work objects.

15. A vacuum hold-down system comprising a base member and a plurality of interchangeable workpiece supports, each of which workpiece supports is capable of co-operating with the base member to define a vacuum chamber, the base member being provided with a venturi having an inlet port for connection to a source of pressurized fluid, an outlet for fluid from the venturi, and a fluid connection from a low pressure region of the venturi to a surface of the base member which will form part of the vacuum chamber, for providing a partial vacuum in the vacuum chamber, which partial vacuum when applied will hold the base member and the workpiece support together to maintain a peripheral seal therebetween; wherein each workpiece support is provided with securing means for securing a workpiece thereon.

16. A system according to claim 15, wherein each of said workpiece supports is of substantially identical construction.

17. A system according to claim 15, wherein at least some of the workpiece supports are of a different construction from each other.

18. A system according to any of claims 15-17, wherein the venturi is disposed substantially entirely within the footprint of the base member.

19. A system according to any of claims 15-18, wherein at least one hole is provided in the base member, providing fluid communication between the inside of the vacuum chamber and an outside surface of the base member, to enable vacuum hold-down of the base member on a supporting surface.

20. A system according to any of claims 15-18, wherein the base member is formed from or provided with a ferromagnetic material to enable it to be secured to a magnetic chuck by magnetism.

21. A vacuum hold-down system substantially as herein described with reference to the drawings.

ABSTRACT

VACUUM HOLD-DOWN

A vacuum hold-down device comprising a base member (1) and a workpiece support (8) which co-operate to define a vacuum chamber. The device further comprises a venturi (15) having an inlet port (7) for connection to a source of pressurized fluid, an outlet (9) for fluid from the venturi, and a fluid connection (19, 5) from a low pressure region of the venturi (15) to the inside of the vacuum chamber, for providing a partial vacuum therein. The partial vacuum will hold the base member (1) and the workpiece support (8) together to maintain a peripheral seal therebetween. The workpiece support (8) is provided with securing means (16) for securing a workpiece (10) thereon. The invention also provides a vacuum hold-down system comprises the base member (1) and a plurality of interchangeable workpiece supports (8).

Fig. 1

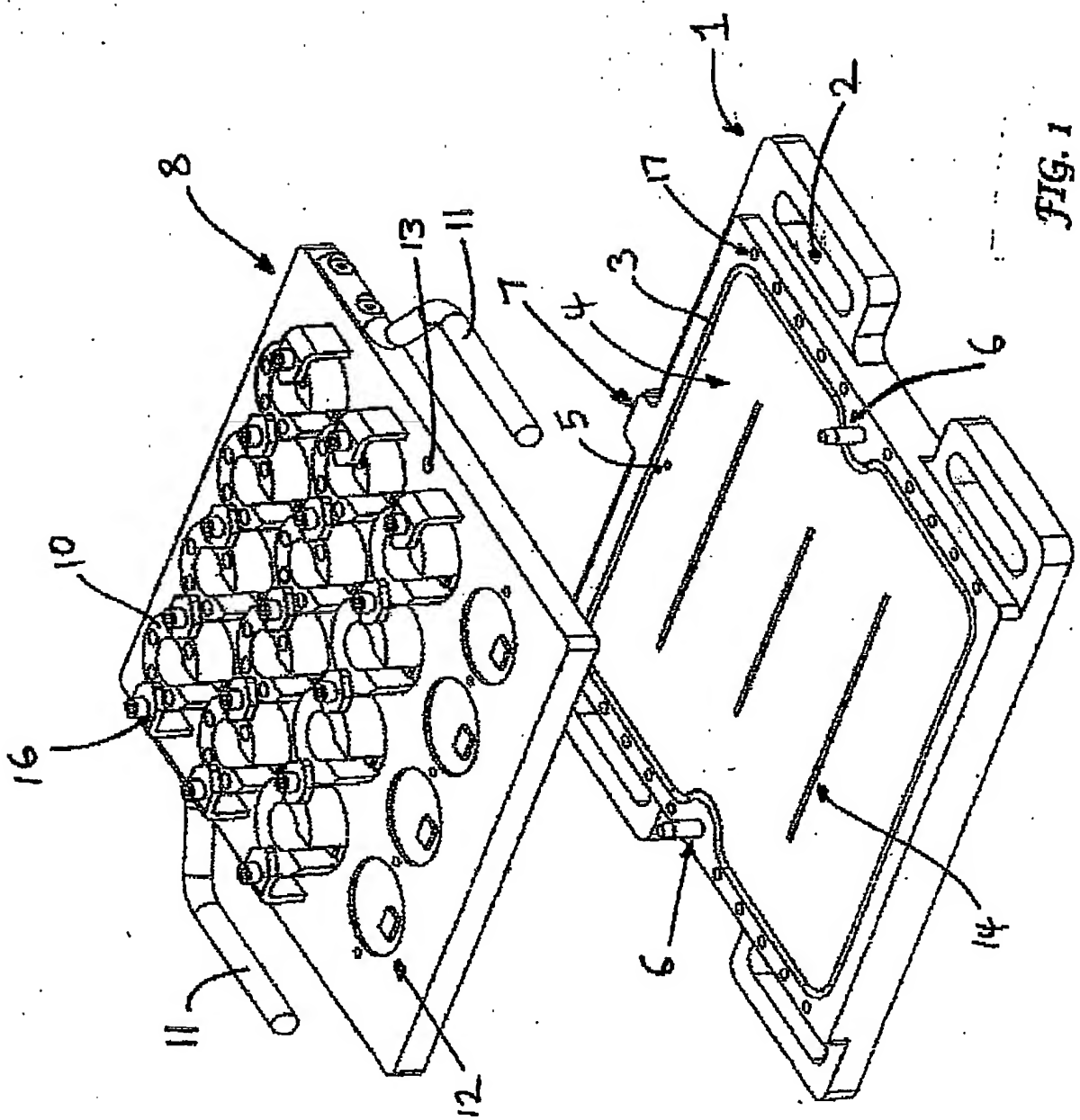


FIG. 1

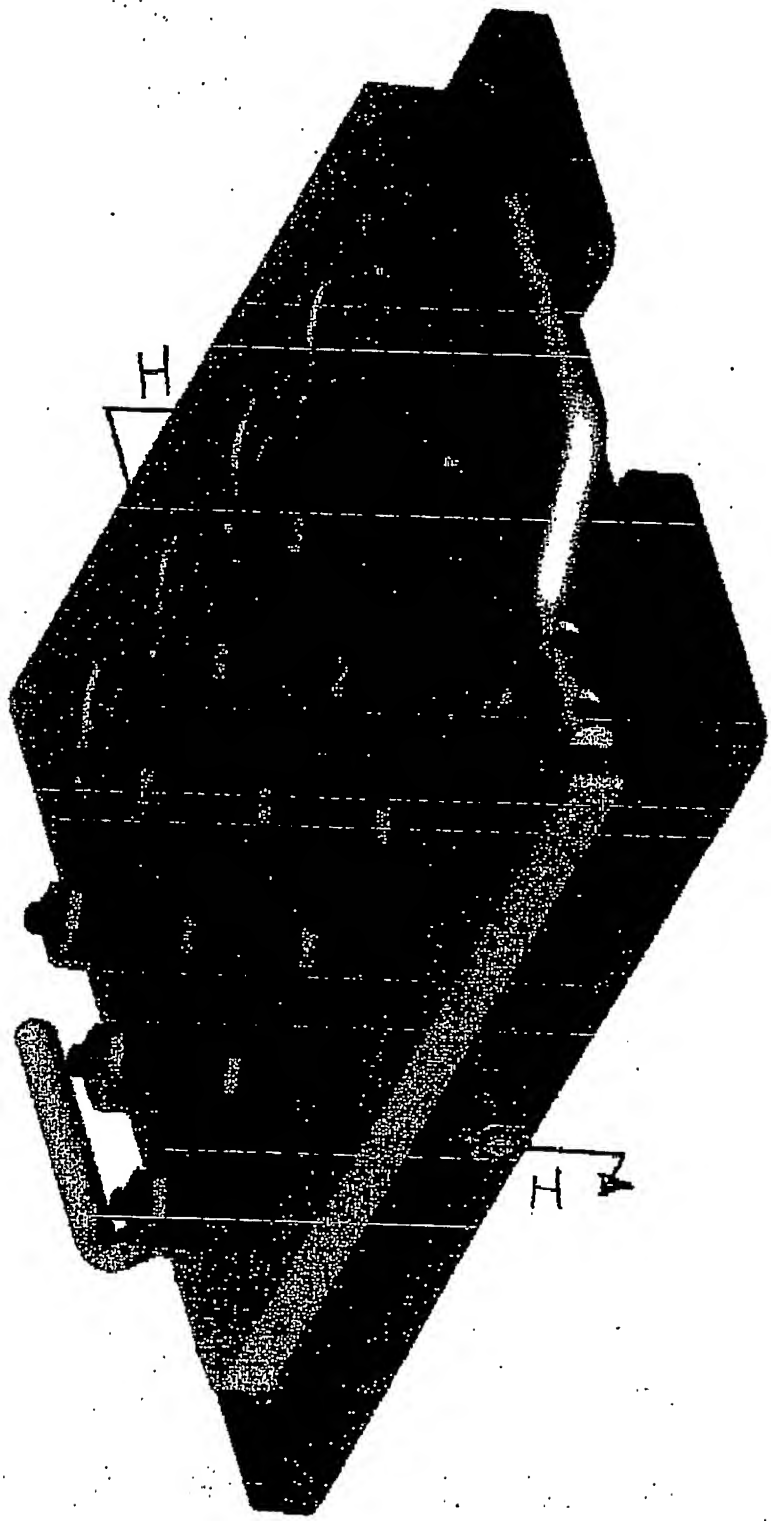


FIG. 2

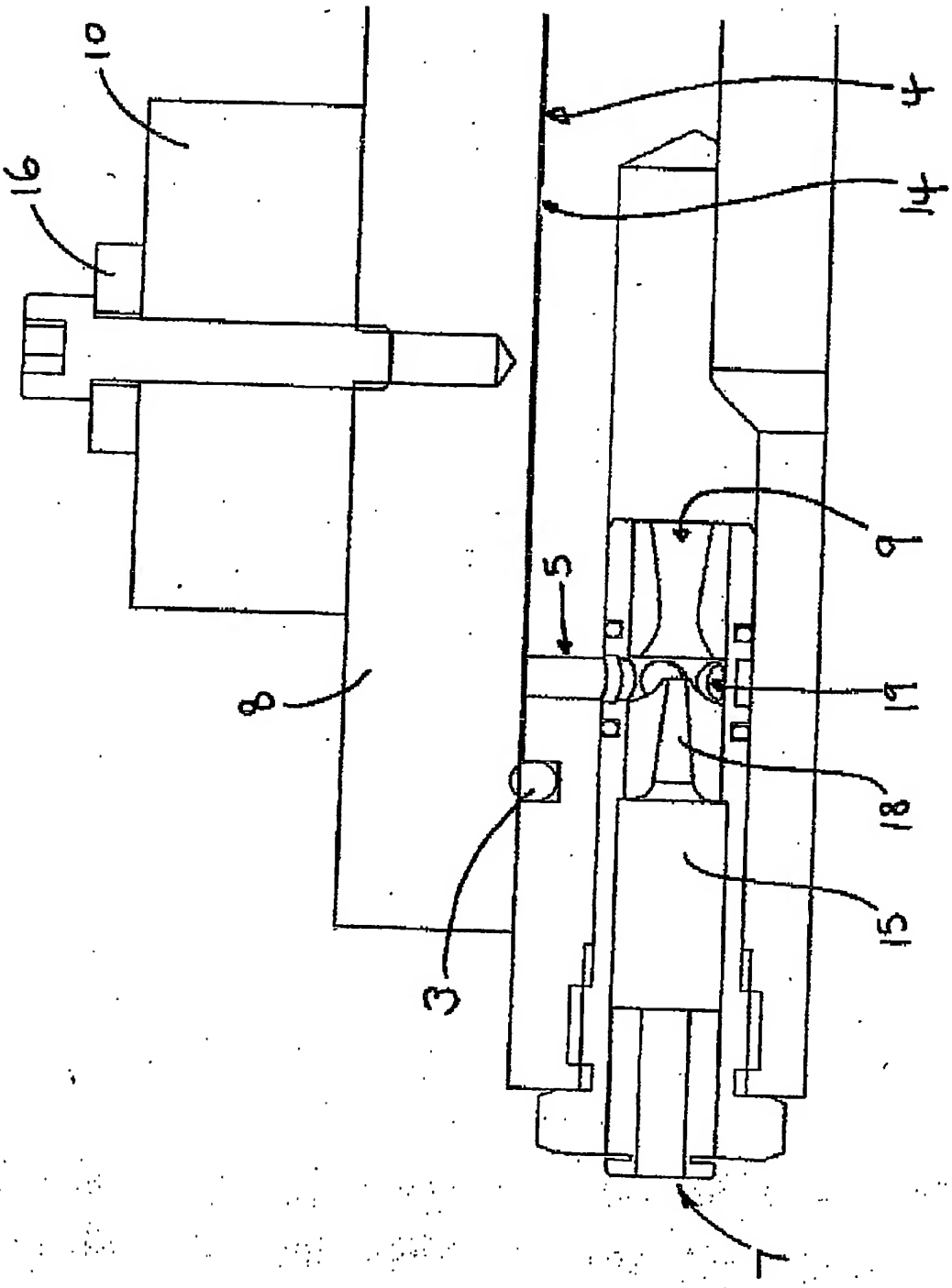


FIG. 3

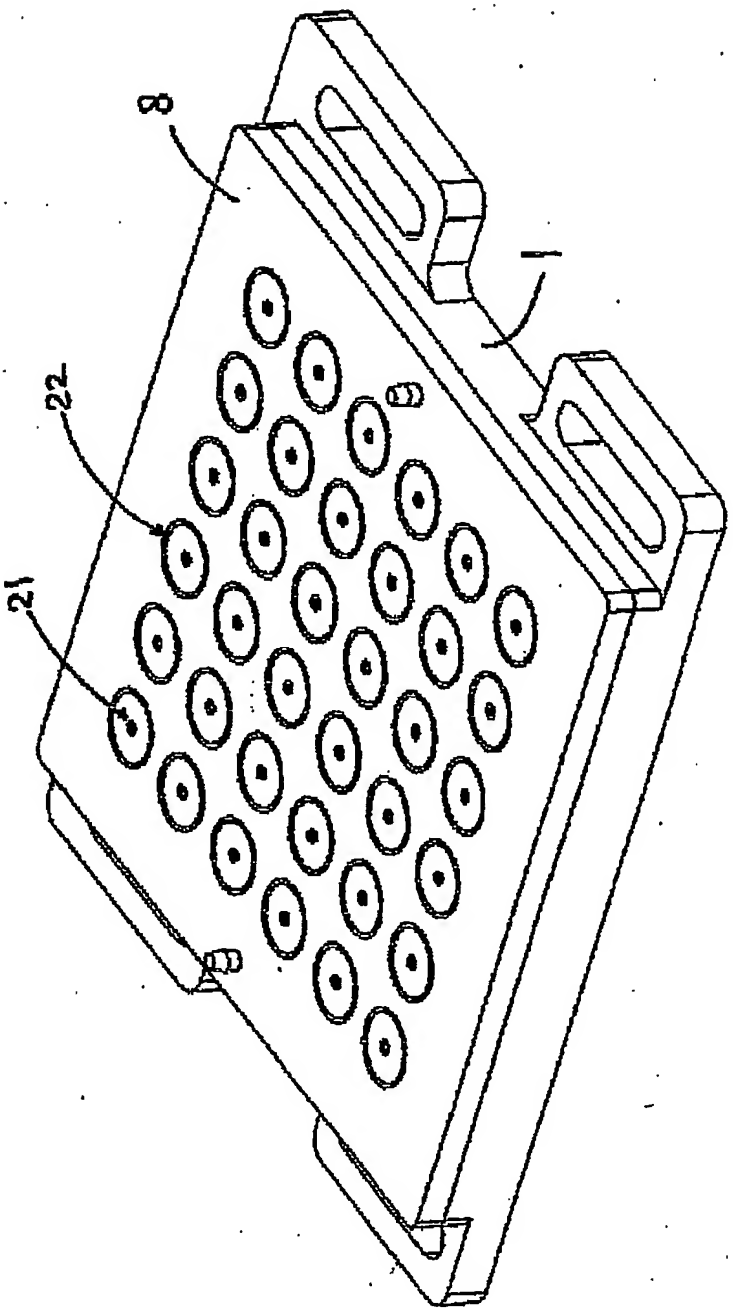


FIG. 4

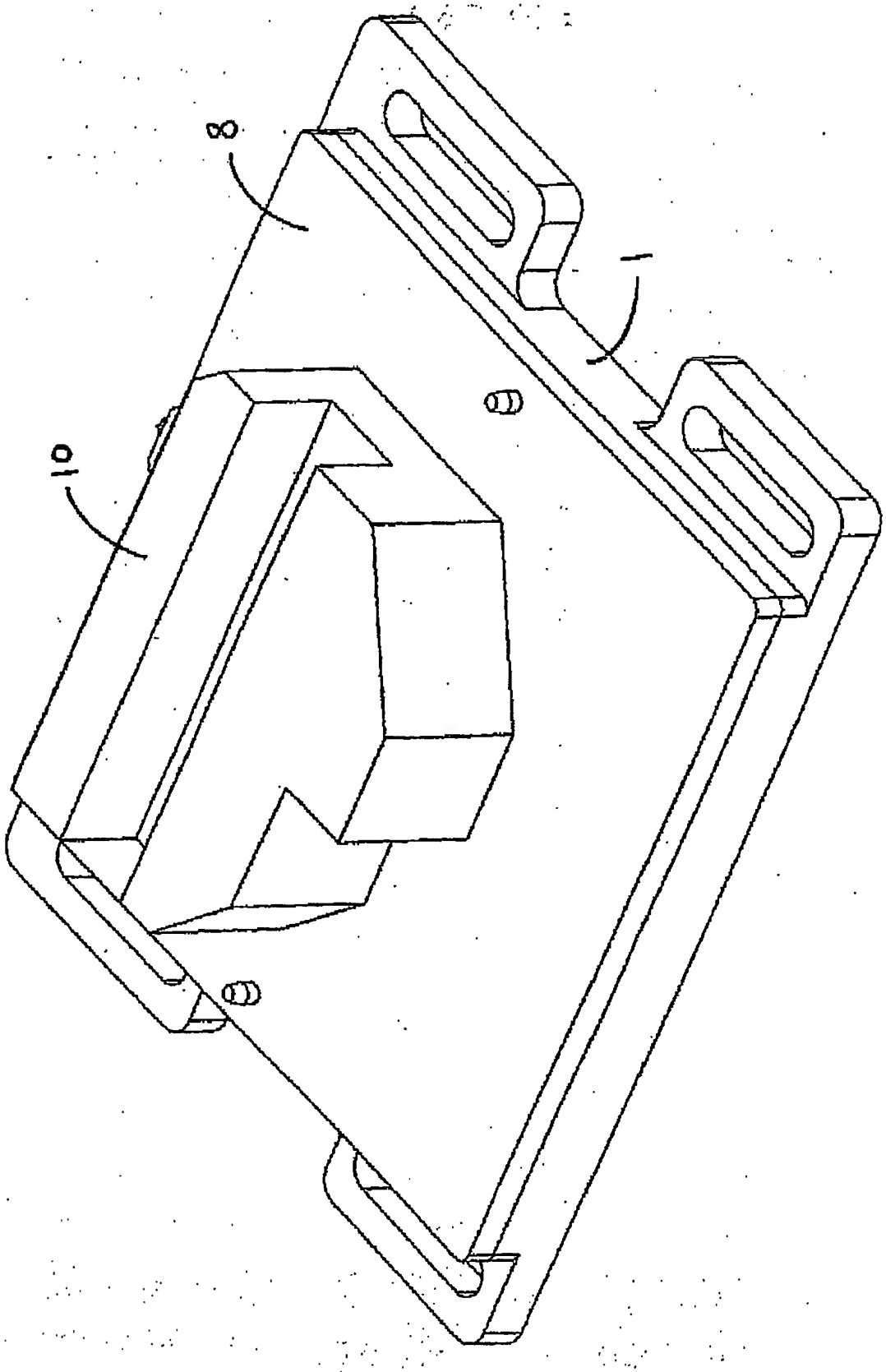


FIG. 5

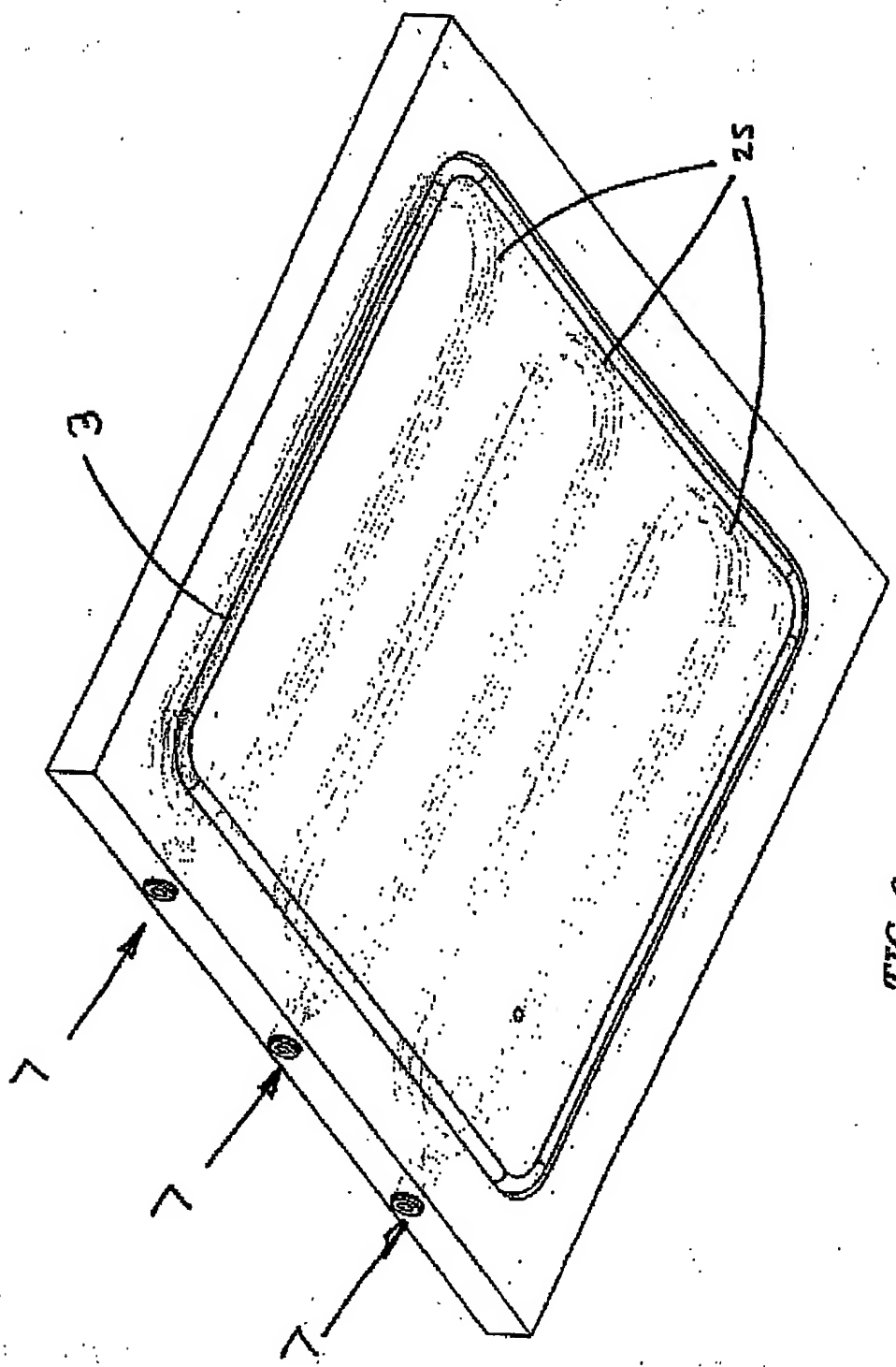


FIG. 6

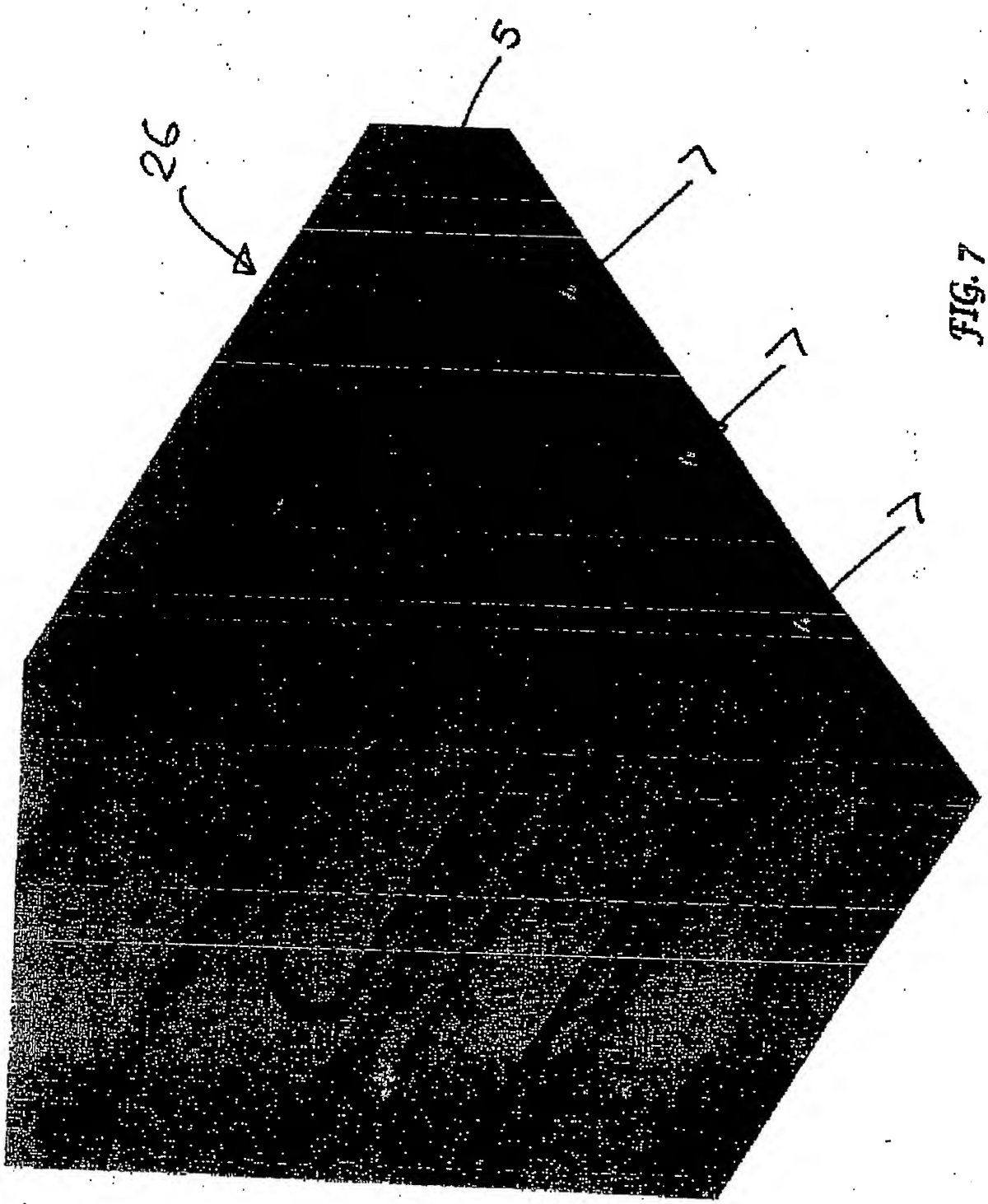


FIG. 7

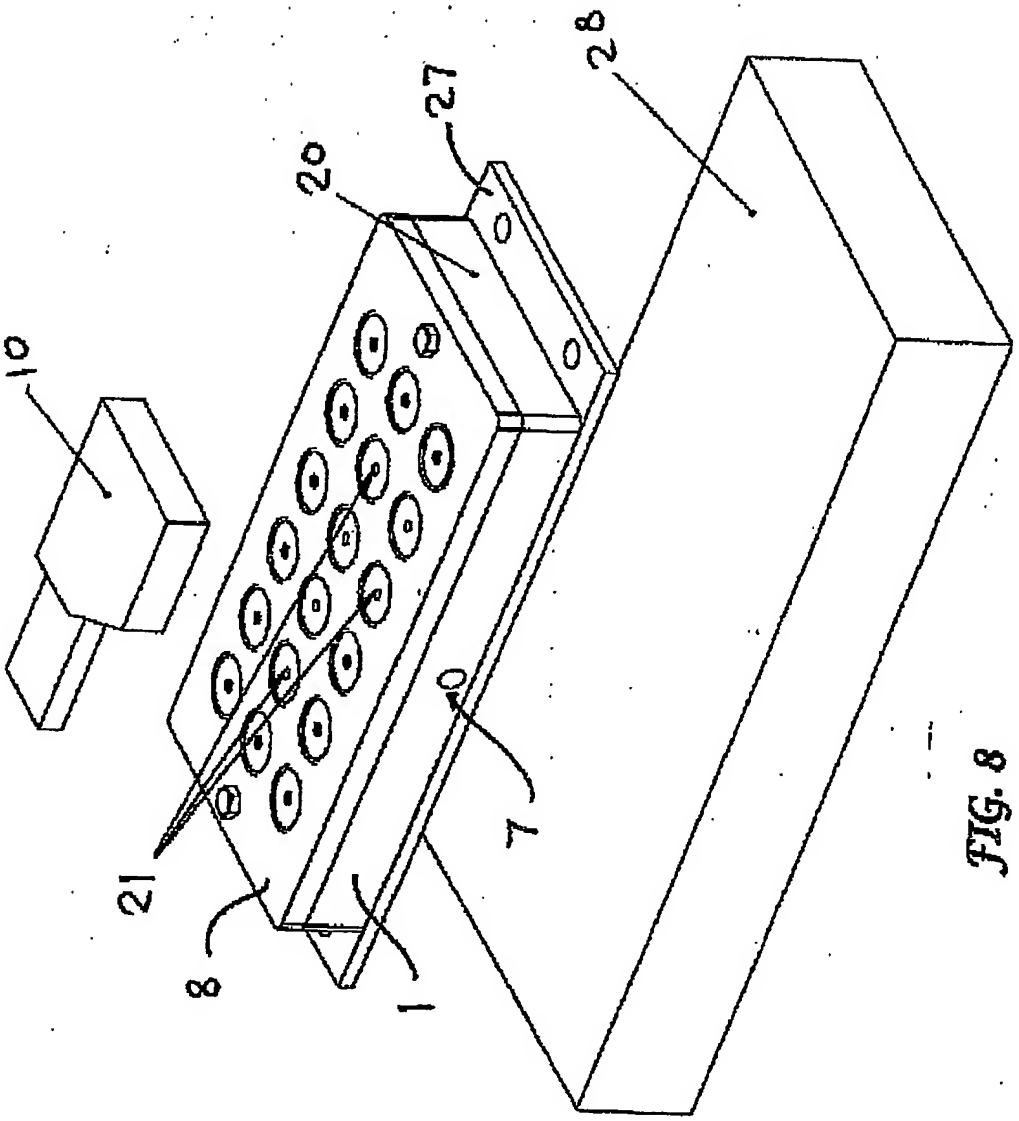
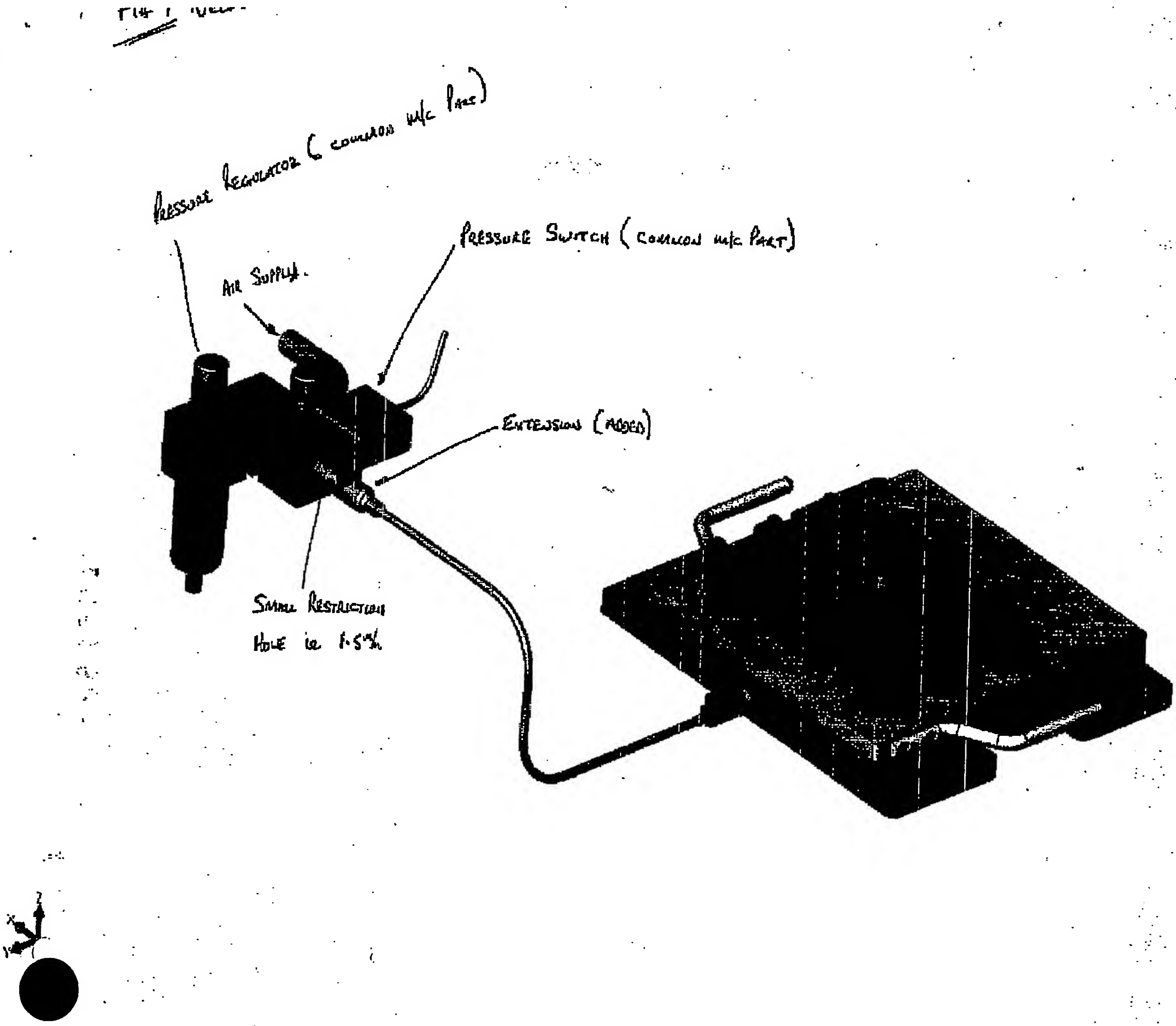
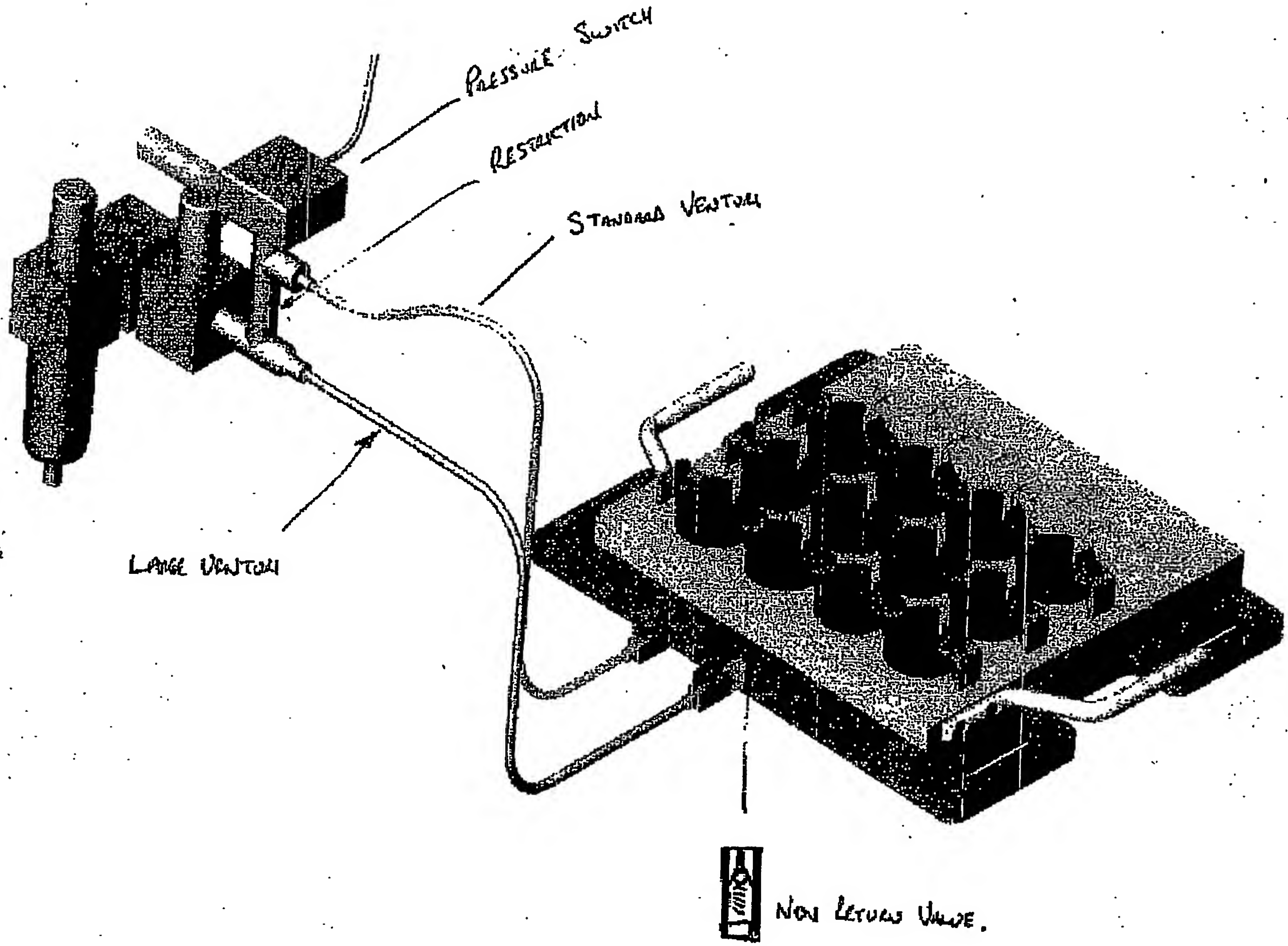


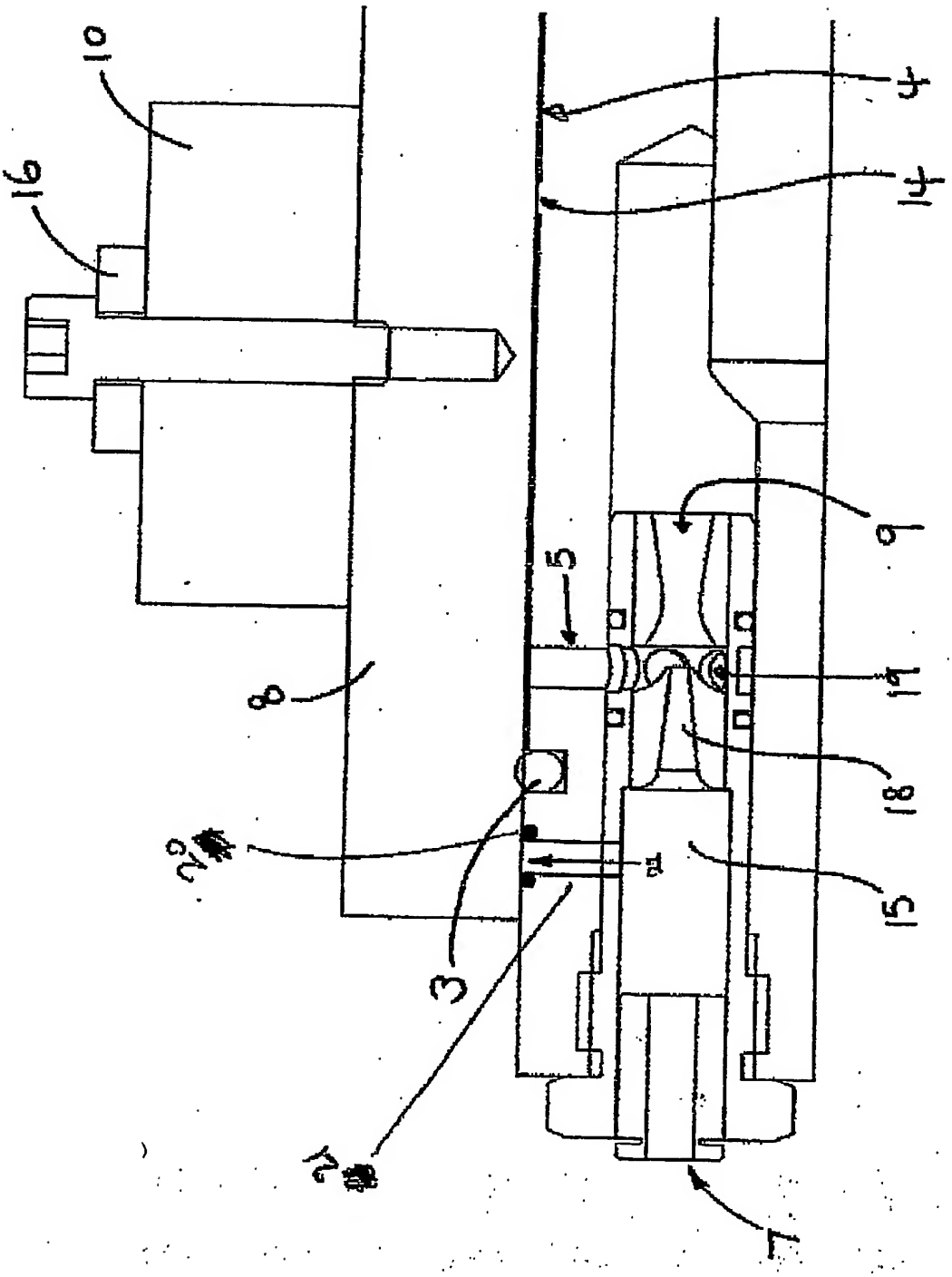
FIG. 8



NEW FIG 2

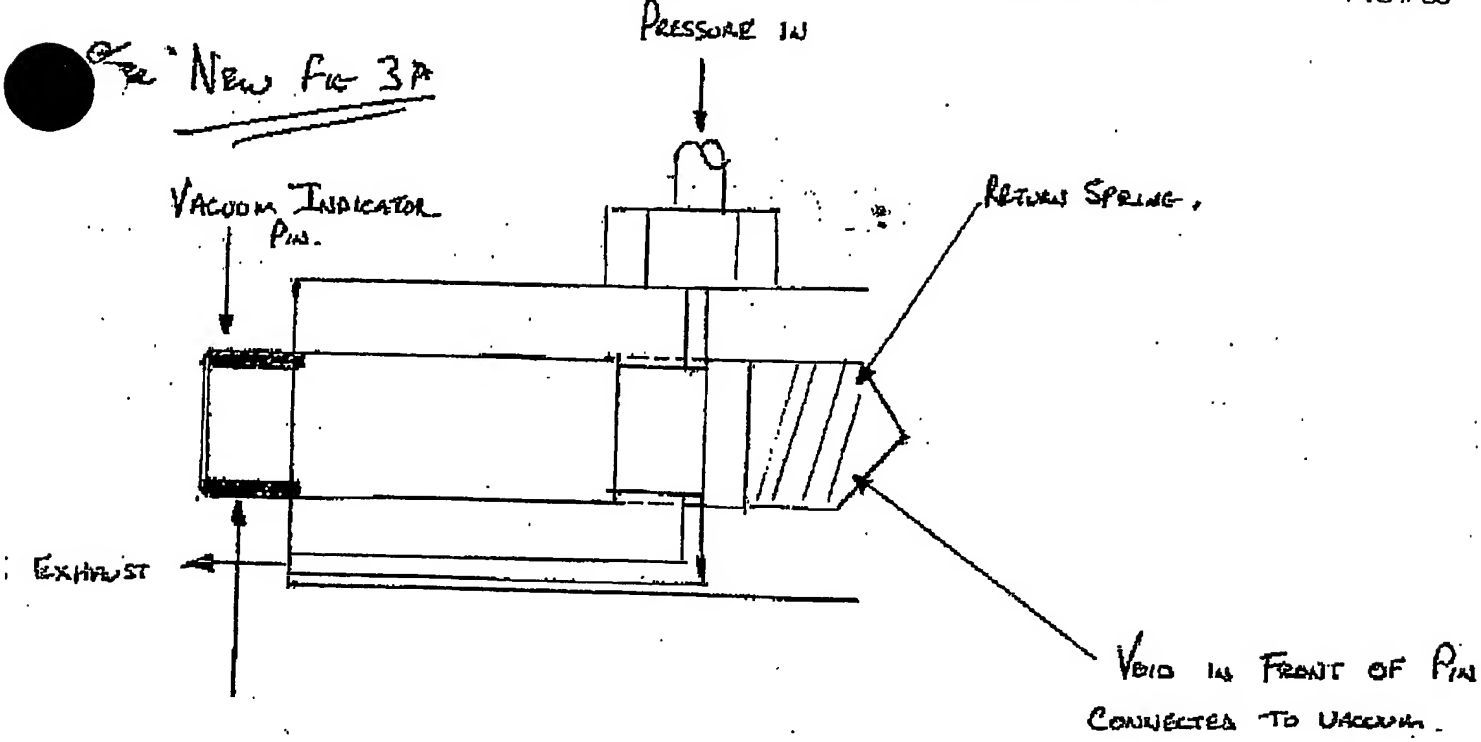

PRESSURE SWITCH
RESTRICTION
STANDARD VENTURI
LARGE VENTURI
NON RETURN VALVE.

3/8



New FIG. 3

New Fig 3A



New Fig 3a

As Above with with Pin in.

All Done Do Drg.'s.

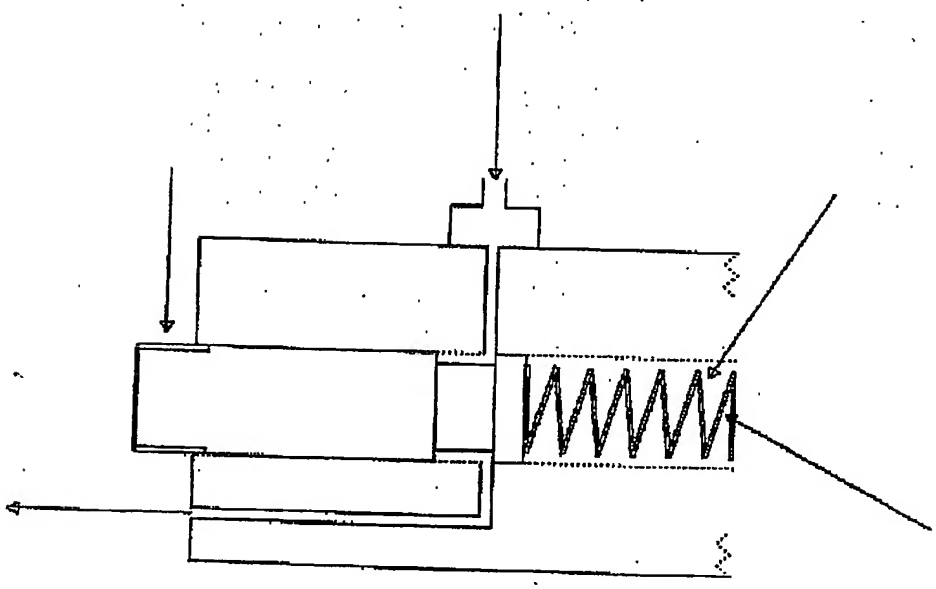


FIG. 9

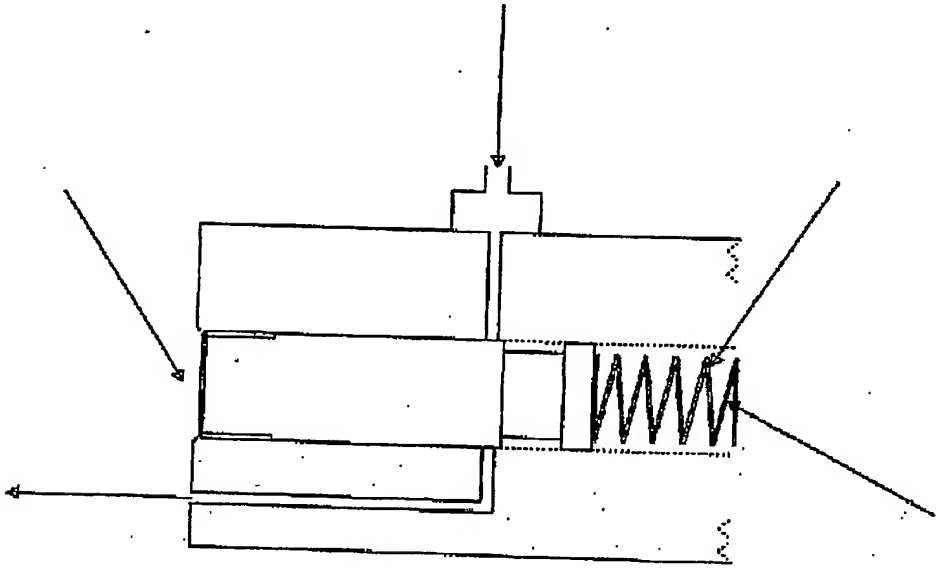


FIG. 16